Replacements for CuBe Bushings

F/A-22/F-35 Mantech Project Proposal

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19 February 2004

Advanced Development Programs

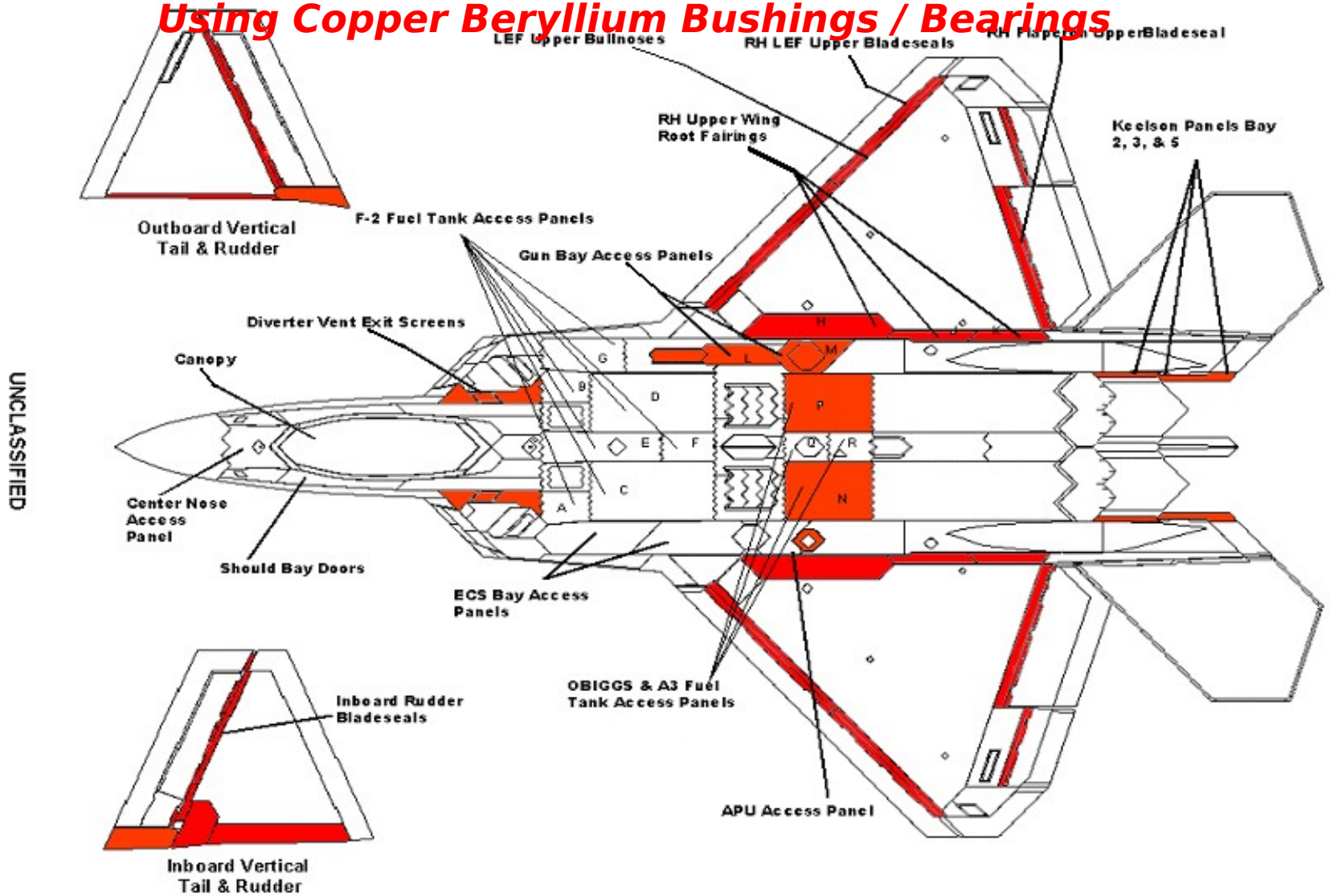
Replacements for CuBe Bushings

Need for Technology

- **F/A-22 Structures Contain CuBe Bushings and Bearings**
  - ***Planned for F-35 use***
  - ***No alternative materials currently qualified***
- **CuBe Particulate Accumulation Presents Health Hazard**
  - ***Higher CuBe accumulation than expected in low airflow areas***
  - ***OSHA recommendation to lower exposure limit to prevent Chronic Beryllium Disease (CBD)***
  - ***Recent aerospace industry incidents have increased concern***
  - ***Current preventative safety practices acceptable yet costly***
    - Fatigue testing
    - Third party monitoring, PPE, ESH & medical monitoring, cleaning

Replacements for CuBe Bushings

F/A-22 Access Panels/Doors Behind Which Are Components Using Copper Beryllium Bushings / Bearings



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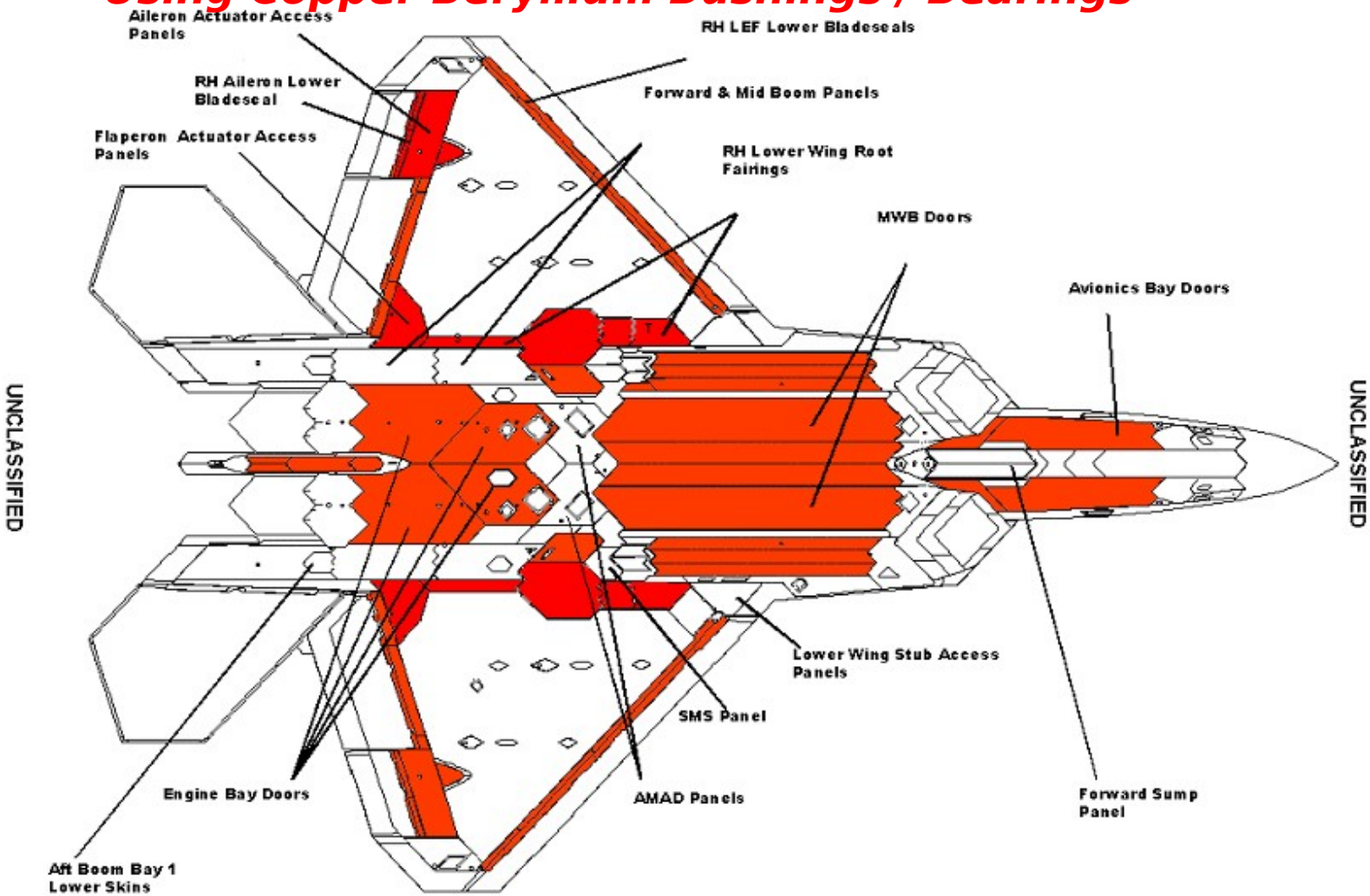


Description of Technology

- **Qualify Non-Beryllium Bushing Material**
  - ***LM Aero funded allowables testing underway for candidates***
    - ToughMet 3AT/ToughMet 3TS CW
    - Nitronic 60 Steel CW
    - Aluminum Nickel Bronze
  - ***Most promising will be chosen for ManTech project testing***

- **Desire "Drop-in" Replacement Bushing Material**
  - ***Needs to meet CuBe mechanical and fatigue properties***
  - ***Limit redesigning or resizing of F/A-22 components***
  - ***Cost similar to CuBe***

Description of Proposed Development Program

- **Task 1 – Fatigue Testing**
  - ***Develop dynamic properties***
  - ***Coupon level testing***
    - Fatigue crack growth rate, strain-life, stress-life, etc.
  - ***Prepare matrix with F/A-22 and F-35 assistance***

- **Task 2 – Component Testing**
  - ***Cyclic fatigue testing of bushings in test fixtures***
    - CuBe versus Replacement Material
  - ***Indicative of loading conditions in F/A-22 and F-35 structures***

Description of Proposed Implementation Program

- **F/A-22 and F-35 Implementation**
  - ***Similar tasks for both programs***
    - Involvement with planning test details and analyzing results
      - *Ensuring program requirements are met*
    - Writing specifications and changing drawings

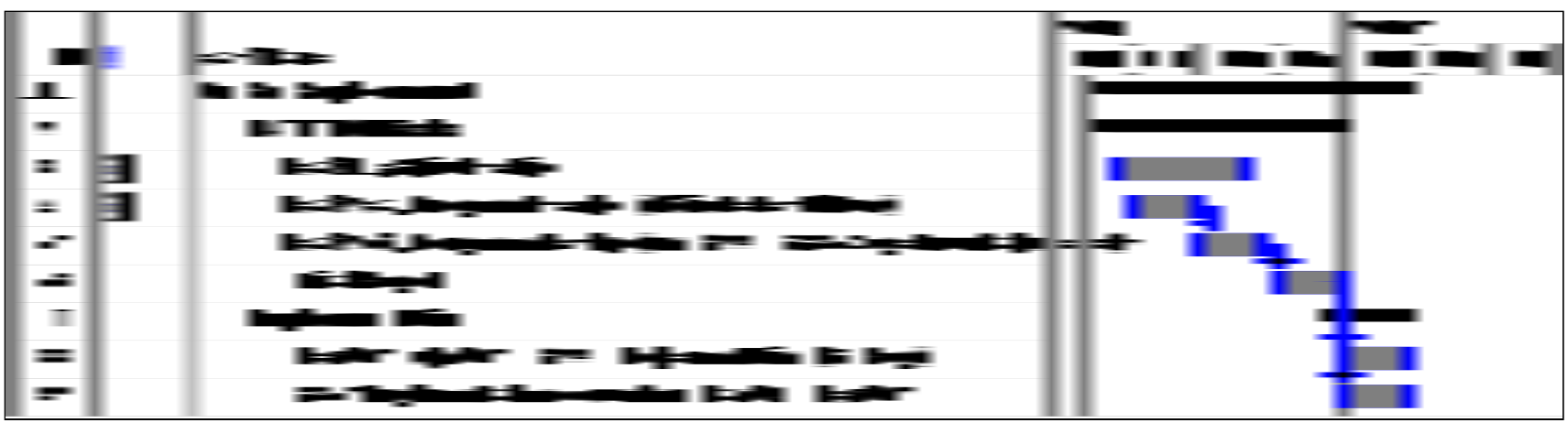
Potential Environmental Funding Sources

- **LM Aero F/A-22 and F-35 Programs**
  - ***Funding initial allowables testing***
  - ***ManTech project takes next step***
    - Fatigue and component tests

- **Pre-proposal submitted for ASC/ENVV Pollution Prevention project, "Alternative to Copper Beryllium" for FY05 funding**
  - ***Further testing proposed***
    - Fracture mechanics, forcemate (FTI) testing, retention testing, determination of shrink fit parameters, bearing cycling testing
  - ***Fully understand alternate bushing material properties***

Development and Implementation Program Schedule

- **F/A-22**
  - *Aiming for implementation in July 2005*
  - *Start of Lot 5 production*
- **F-35**
  - *Implementation targeted ASAP but no later than LRIP Lot 1*



Proposed Development and Implementation Costs

- **F/A-22 Costs**
  - *$210,000 in labor and testing costs*
  - *$66,000 in F/A-22 labor for oversight and qualification efforts*
  - *$408,000 total F/A-22 cost*
- **F-35 Costs**
  - *$133,000 in F-35 labor for oversight and qualification efforts*
  - *$196,000 total F-35 cost*
- **Cumulative total of $604,000**

Replacements for CuBe Bushings

Estimated Cost Savings

- **Production cost savings of $89,000 per site**
- **Present fleet life sustainment cost impact due to the presence of CuBe on F/A-22 is $7,208,400 (ROM)**
- **Includes sustainment costs plus a 5 yr Base BioBEE / industrial hygiene monitoring program at each base**
- **F/A-22 RM of 3.5**
- **F-35 RM of 13.6**

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AERONAUTICAL SYSTEMS CENTER (AFMC)
WRIGHT-PATTERSON AIR FORCE BASE OHIO

10 DEC 2003

MEMORANDUM FOR ASC/CC
HQ AFMC/LG

FROM: ASC/YF

SUBJECT: F/A-22 Copper Beryllium Component Wear Accumulation

1. During fatigue testing, the F/A-22 Program experienced unpredicted accumulation of Copper Beryllium (CuBe) particulate from bushing and bearing wear. Due to its unique properties, CuBe is used by the F/A-22 and many other weapon systems as the standard for high load bushings and bearings. Based on fatigue article experience, our challenge was to analyze the accumulation potential on flight hardware. The analysis concluded the majority of F/A-22 CuBe components did not have the potential to accumulate wear particulate. However, in a limited number of areas CuBe particulate accumulation potential remains due to airframe configuration, low airflow through some bays, and infrequent access to those areas.

2. The concern with CuBe particulate accumulation is the potential maintainer exposure hazard due to the low occupational exposure limit for Beryllium (Be), Be compounds, and Be alloys. Medical evidence indicates occupational exposure to Be compounds has several potential adverse health effects, with the most serious related to inhalation of fine Be particulate. Occupational exposure can also occur as a result of CuBe part alteration and corrosion control procedures. The F/A-22 Program utilizes procedural controls and Personal Protective Equipment to control beryllium exposure in these circumstances.

3. Based on F/A-22 Program experience, recommend evaluating weapon system configurations for CuBe wear components in infrequently accessed, low airflow areas for potential accumulation of wear particulate. In addition, recommend reviewing weapon system CuBe component part alteration and corrosion repair technical data for procedures and warnings to prevent and protect against creating a potential CuBe particulate exposure hazard.

4. The F/A-22 SPO point of contact is Mr. Jared Scott, ASC/YFAI, DSN 674-5269 or e-mail jared.scott@wpafb.af.mil.

THOMAS J. OWEN
Brigadier General, USAF
F/A-22 System Program Director

Attachment:
F/A-22 CuBe Point Paper